(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 May 2001 (10.05.2001)

PCT

(10) International Publication Number
WO 01/33747 A1

(51) International Patent Classification[7]: H04B 10/10, 10/16

(21) International Application Number: PCT/AU00/01340

(22) International Filing Date:
1 November 2000 (01.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PQ 3782 1 November 1999 (01.11.1999) AU
PQ 8748 12 July 2000 (12.07.2000) AU

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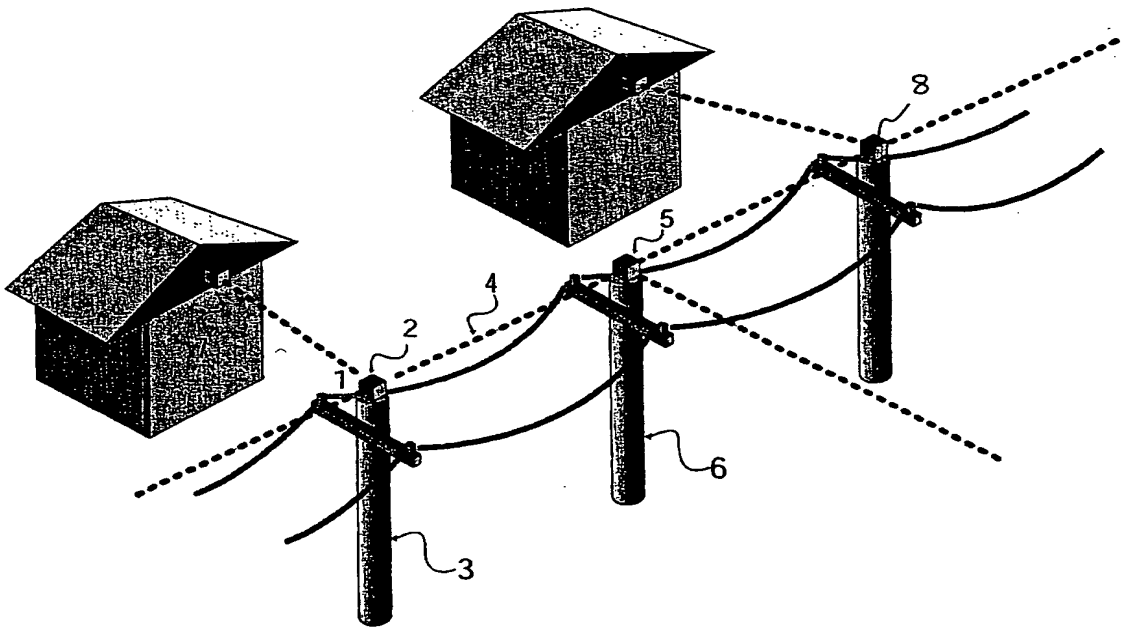
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: OPTICAL DATA NETWORK



(57) Abstract: An interconnection network including: a series of repeater transceivers (2, 5, 7, 8), the transceivers being arranged, in use, to transmit data signals between them in the form of laser pulses transmitted through the air. The repeater transceivers (2, 5, 7, 8) are mounted, in use, on one or more of the group of existing power poles (3, 6), existing street lighting poles, and existing telegraph poles.

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Optical Data Network

Field of the Invention

The present invention relates to the field of data transmission and, in particular, to the transmission of data to a large number of households or the like.

Background of the Invention

Recently, it has become increasingly important to "wire up" neighbourhoods to a data transmission medium which is interconnected to the Internet and provides for a high bandwidth form of transmission.

Often, a severe bottleneck in Internet access is the last connection stage from a wired area or international network to households. This last connection is commonly known as the "local loop" or "the last mile". The most common form of data transmission over the local loop is to utilise the traditional framework of telecommunications carriers and to utilise copper cable interconnect. Unfortunately, the copper cable interconnect of standard telephone systems have limited bandwidth and, in most cases, the telephone system to the home is bandwidth limited to the utilisation of 56,000 bits per second via a telephone modem. New cable modems often provide a higher bandwidth but require a total cable rewiring of a neighbourhood. This leads to widespread community dissatisfaction with unsightly co-axial cabling systems for cable television and Internet usage.

Wireless alternatives such as satellite and RF data systems have been proposed but suffer from regulatory problems with spectrum allocation and, in the case of satellite, a high speed inbound data rate but very low outbound data rate (the outbound data rate being typically over standard phone lines.

Summary of the invention

It is an object of the present invention to provide for an alternative form of data transmission to and from e.g. a collection of houses.

In accordance with a first aspect of the present invention, there is provided an interconnection network including: a series of repeater transceivers, the transceivers being arranged, in use, to transmit data signals between them in the form of laser pulses transmitted through the air.

The repeater transceivers are preferably mounted, in use, on one or more of the group of existing power poles, existing street lighting poles, and existing telegraph poles.

Preferably, the network further comprises a series of terminal transceivers mounted, in use, adjacent to corresponding destination areas to and from which data signals are to be transmitted over the interconnection network, the terminal transceivers being arranged, in use, to transmit to and receive data signals from at least one repeater transceiver in the form of laser pulses transmitted through the air.

Preferably, the network is configured with some of the destination areas located in one or more of the group of a harbour, a river or a foreshore environment and some of the repeater transceivers are located on harbour, river or foreshore areas.

At least one of the repeater or terminal transceivers preferably can include a background noise suppression means for suppressing background noise around the repeater or terminal transceivers.

The network can further be arranged, in use, in a manner such that the data signals are transmitted in portions of the network by means of radio frequency or other frequency electromagnetic emissions.

The repeater transceivers are preferably powered by one or more of the group of solar panels, power cells, wind or tidal power generation mechanisms.

The network can further include mirrors to facilitate, in use, transmission of the data signals around obstacles and/or optical fibre for transmitting the data signals, in use, around obstacles. The fibre preferably has optical amplification and/or switching capabilities.

The network is preferably arranged in a manner such that, in use, the laser pulses are beam expanded.

The network may be arranged in a manner such that, in use, backreflection interference is being reduced by means of at least one of the group of Anti reflection coatings, angled or textured surfaces, beam splitters, half-slivered or angled mirrors, modulation of the light signals, and transmission at different wavelengths.

In accordance with a second aspect of the present invention, there is provided a method of providing an interconnection to destination points within an interconnection network, the

method including the step of transmitting data signals in the form of laser pulses transmitted through the air between a series of repeater transceivers.

In accordance with a third aspect of the present invention there is provided a repeater transceiver arranged, in use, to transmit and receive data signals in the form of laser pulses transmitted through the air from other repeater transceivers, for providing an interconnection to destination points within an interconnection network.

The transceiver preferably includes means for, in use, mounting the transceiver to on of the group of existing power poles, existing street lighting poles, and existing telegraph poles.

Brief description of the drawings

Notwithstanding any other forms which may fall within the scope of the present invention, preferred forms of the invention will now be described, by way of example only with reference to the accompanying drawings in which:

Fig. 1 illustrates schematically the arrangement of the preferred embodiment;

Fig. 2 is a schematic illustration of the design of a repeater module;

Fig. 3 illustrates the utilization of the preferred embodiment in a harbour environment;

Fig. 4 illustrates the utilization of a backing board with a repeater module so as to minimize background noise.

Description of the Preferred and other Embodiments

In the preferred embodiment, the infrastructure of the power supply system and, in particular, power supply poles, is utilised to provide for free space data communication between adjacent power poles. As a substantial amount of power supply is still being provided by overhead wiring on power poles, the power poles can be utilised as a data staging and transmission device carrier utilising inferred data communications. Preferably, high performance, long range line of sight optical data transmission is provided utilising devices such as those available from Astroterra Corporation who market a device able to provide for high speed transmission utilising infrared data communications.

The utilisation of the overhead power supply and power poles has the added advantage that because of the danger of fire and supply interruption, power supply authorities and companies have diligently removed trees and other obstructions from the vicinity of power

poles and power lines. There is therefore an increased likelihood of line of sight thoroughfare around the city or neighbourhood from power pole to power pole.

Further, a large segment of the worlds population lives close to the sea or to rivers. For example, where a harbour is present, then this is a huge resource of open space that is able to provide line of sight communications to a large number of homes.

The preferred embodiment therefore comprises a number of portions of hardware which most importantly include a series of repeater modules. As illustrated in Fig. 1, the repeater modules eg. 2 are located on power poles eg. 3 within the line of sight 4 of other modules eg. 5 which are also located on power poles eg. 6. A series of terminal modules eg. 7 are mounted on houses or buildings and provide for end termination of the data transmission.

Power for the repeaters eg. 2, 5 can be obtained from the power supply on the corresponding pole or alternatively, solar panels or batteries could be utilised. The terminal modules 7 are mounted within a line of sight of repeater module 8 and power for the terminal module can be supplied by the end user. The terminal modules include a relevant interface adaptor for data delivery to the end-user's equipment such as computers, telephones, televisions etc.

The repeater modules e.g. 2, 5, 8 may also contain switching hardware that allows data to be routed intelligently to its destination rather than being repeated throughout the network. In this manner the operation can be similar to a packet switch network such as the TCP - IP Internet Protocol.

An example schematic structure of a repeater module can be as illustrated in Fig. 2 wherein a series of receivers eg. 10 are provided for receiving signals from other repeater modules. The information received is controlled and routed by a control and routing chip 11 to a series of transmitters 12. The control and routing chip 11 can be an ASIC circuit implementing routing operation in a similar matter to standard Internet packet routing systems.

As a further application, the repeater modules can themselves be fitted with cellular telephony base stations or mobile phone communication. As a result of the likely small cell size, extremely low power portable equipment can be utilised and other frequencies previously unusable can be attained. Further the small cell size also fosters a dual use high resolution tracking and navigation utilization of the interconnect.

The software provided for the overall control of the system can include a switching network protocol for data transmission, a synchronous broadcast protocol for real time media such as video and a network management software infrastructure to handle billing, routing, fault analysis etc.

The utilization of an in-air laser transmission interconnect can have a number of benefits. Firstly, the system can utilize a wider bandwidth than say a fibre system because the propagation is not dependant upon frequency as in a dispersive fibre. Further, utilizing both wideband links and a switched packet network also increases overall performance of the system. The system does not require the laying of fibre cables and can be implemented utilizing commodity parts which can be mass produced. The facilities can be highly flexible and upgradable as need be. Further, other modifications are possible. For example, where a river or harbour structure is present, then a repeater module can be located on a headland or around the river or the harbour so as to provide for an excellent backbone infrastructure for the system. A schematic example of such an arrangement is illustrated in Fig. 3 wherein a repeater module 20 is located on an island structure in a harbour and communicates with a second repeater module 21 located on the foreshores. In order to enhance the performance of the point to point link, each transmitting station as illustrated in Fig. 4 can include a backing board eg. 25 of an arbitrary size which helps discriminate the transmitted signal from background noise.

A number of further refinements are possible to the above arrangements. For example, in a first refinement, radio frequency or other frequency electromagnetic connections between the pole-mounted repeater/switch units can be made both between poles and poles and substations. These connections can be via both directional and general emitters.

Further, the system can be mounted on other types of poles including street lighting poles or telegraph poles. Further the system can be driven by various power sources including solar panels or other power cells mounted on the poles. Alternatively, wind or tidal power can be provided for remote locations.

The system can further include mirror to transmit around obstacles. Further, this can be extended to utilise fibre transmission to transmit around obstacles before returning to in-air transmission once the obstacle has been passed. The utilisation of fibre segments can allow for all optical amplification and switching capabilities during transmission.

Further, beam expansion techniques can be used to widen a transmitted beam to a parallel cylinder for eye safety and resistance to scintillation effects can be provided. Suitable

arrangements can include Cassegrain or Schmidtt-Cassegrain optics (such as those set out in US patents 4,054,364 and 5,500,520. Alternative modes of expansion can be provided via beam expansion on the end of a fibre bundle or a lens arrangements.

In certain arrangements, it is somewhat less expensive to utilise the same optical path for both the transmit and receive on a link. Therefore it is desirable to minimize reflections from the transmitter coming straight back and interfering with the receiver in the same unit. This can be provided by a combination of the following techniques:

(a) Anti reflection coatings on the front and inside surfaces of each unit;

(b) angled surfaces around a receiver so that reflections go off at an angle and transmission goes straight through can be used. A textured surface having zig zag pattern or suitably constructed irregular surfaces can also be used to minimise back reflections.

(c) A beam splitter or half-slivered, angled mirror may also be suitable. Ideally, it is mounted do the same job - but mount it close to the photodiode and LED at the focal point of the optics to maximize suppression.

(d) Modulating the light signal with an identifying code (CDMA, FM, etc) that is unique for each direction.

(e) Utilising a separate wavelength for each direction.

It would be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

Claims

1. An interconnection network including: a series of repeater transceivers, the transceivers being arranged, in use, to transmit data signals between them in the form of laser pulses transmitted through the air.

2. A network as claimed in claim 1, wherein the repeater transceivers are mounted, in use, on one or more of the group of existing power poles, existing street lighting poles, and existing telegraph poles.

3. A network as claimed in claims 1 or 2, wherein the network further comprises a series of terminal transceivers mounted, in use, adjacent to corresponding destination areas to and from which data signals are to be transmitted over the interconnection network, the terminal transceivers being arranged, in use, to transmit to and receive data signals from at least one repeater transceiver in the form of laser pulses transmitted through the air.

4. A network as claimed in claim 3, wherein the network is configured with some of the destination areas located in one or more of the group of a harbour, a river or a foreshore environment and some of the repeater transceivers are located on harbour, river or foreshore areas.

5. A network as claimed in any one of the preceding claims, wherein at least one of the repeater or terminal transceivers includes a background noise suppression means for suppressing background noise around the repeater or terminal transceivers.

6. A network as claimed in any one of the preceding claims, wherein the network is further arranged, in use, in a manner such that the data signals are transmitted in portions of the network by means of radio frequency or other frequency electromagnetic emissions.

7. A network as claimed in any one of the preceding claims, wherein the repeater transceivers are powered by one or more of the group of solar panels, power cells, wind or tidal power generation mechanisms.

8. A network as claimed in any one of the preceding claims, wherein the network further includes mirrors to facilitate, in use, transmission of the data signals around obstacles.

9. A network as claimed in any one of the preceding claims, wherein the network further includes optical fibre for transmitting the data signals, in use, around obstacles.

10. A network as claimed in any one of the preceding claims, wherein the network is arranged in a manner such that, in use, the laser pulses are beam expanded.

11. A network as claimed in any one of the preceding claims, wherein the network is arranged in a manner such that, in use, backreflection interference is being reduced by means of at least one of the group of Anti reflection coatings, angled or textured surfaces, beam splitters, half-slivered or angled mirrors, modulation of the light signals, and transmission at different wavelengths.

12. A method of providing an interconnection to destination points within an interconnection network, the method including the step of transmitting data signals in the form of laser pulses transmitted through the air between a series of repeater transceivers, wherein the repeater transceivers are mounted, in use, on one or more of the group of existing power poles, existing street lighting poles, and existing telegraph poles.

13. A repeater transceiver arranged, in use, to transmit and receive data signals in the form of laser pulses transmitted through the air from other repeater transceivers, for providing an interconnection to destination points within an interconnection network, the transceiver including means for, in use, mounting the transceiver to on of the group of existing power poles, existing street lighting poles, and existing telegraph poles.

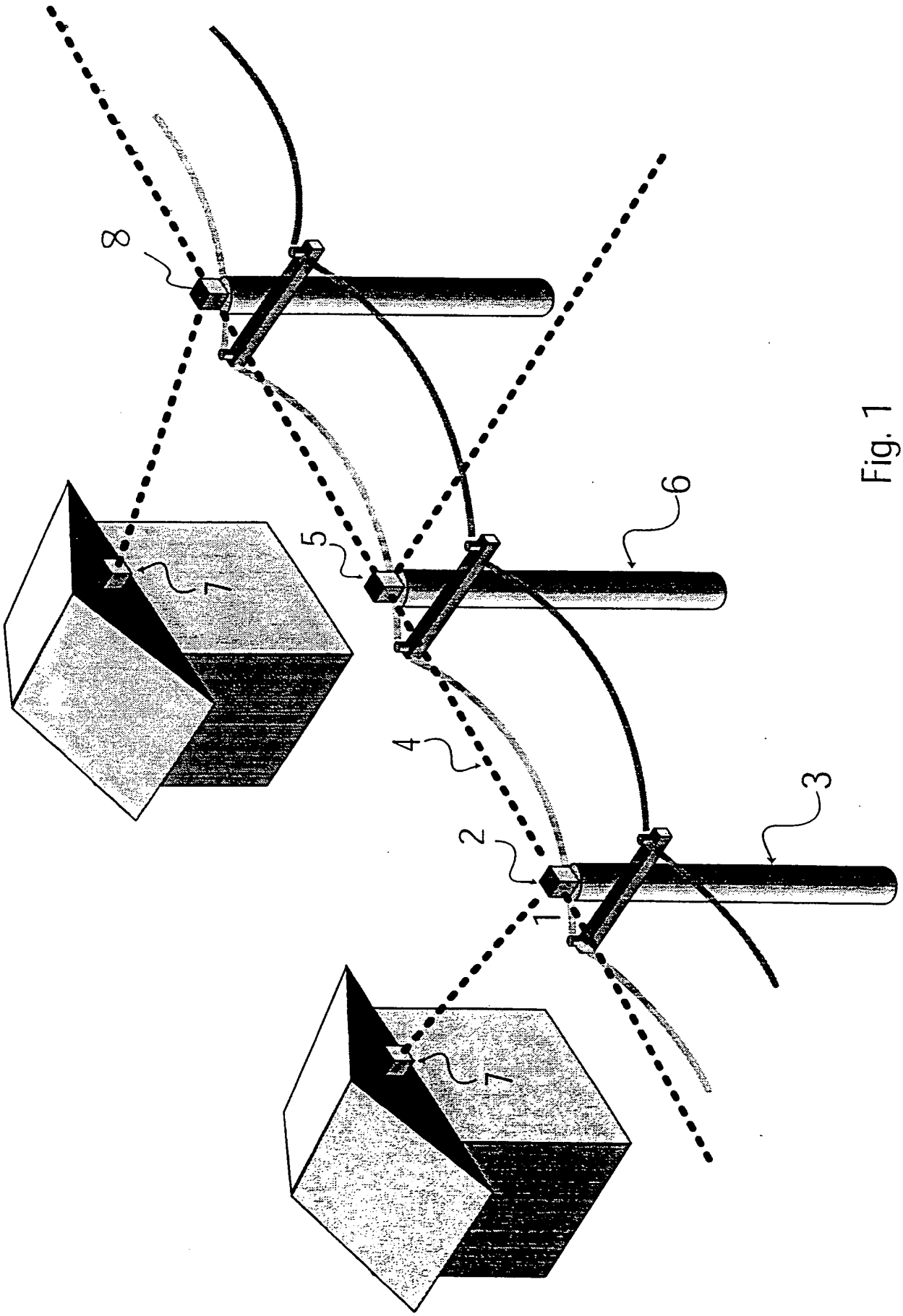
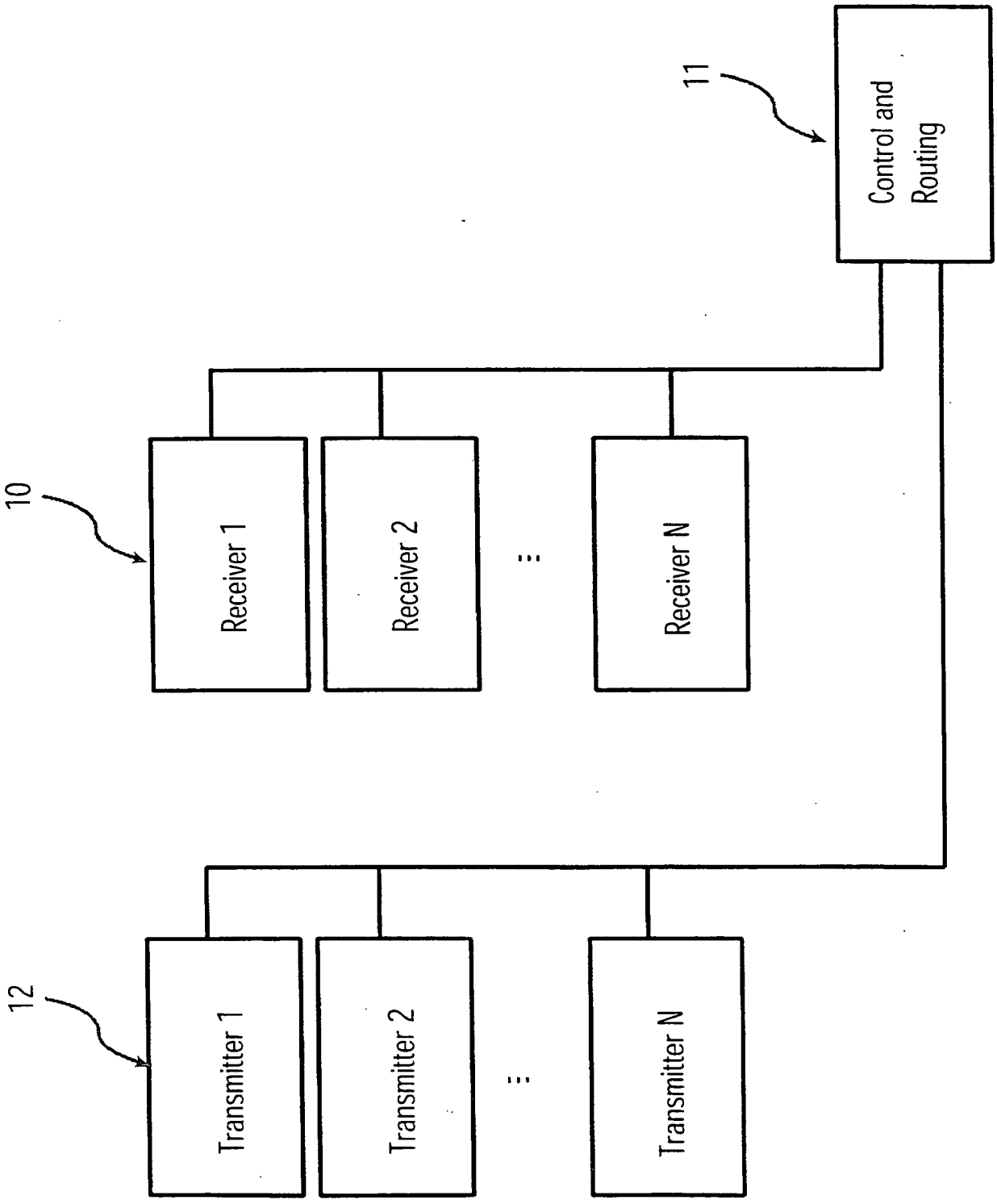


Fig. 1

Fig. 2



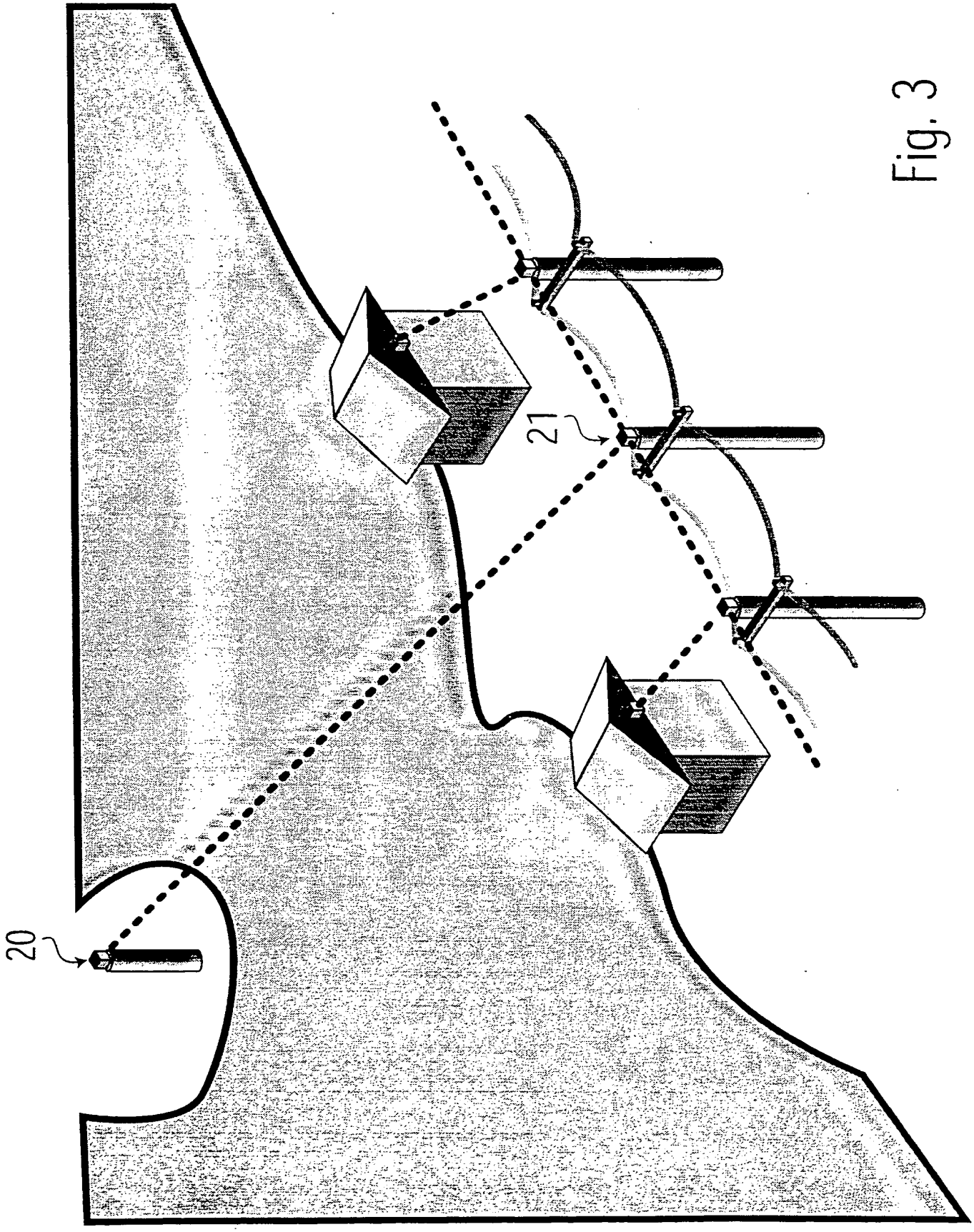
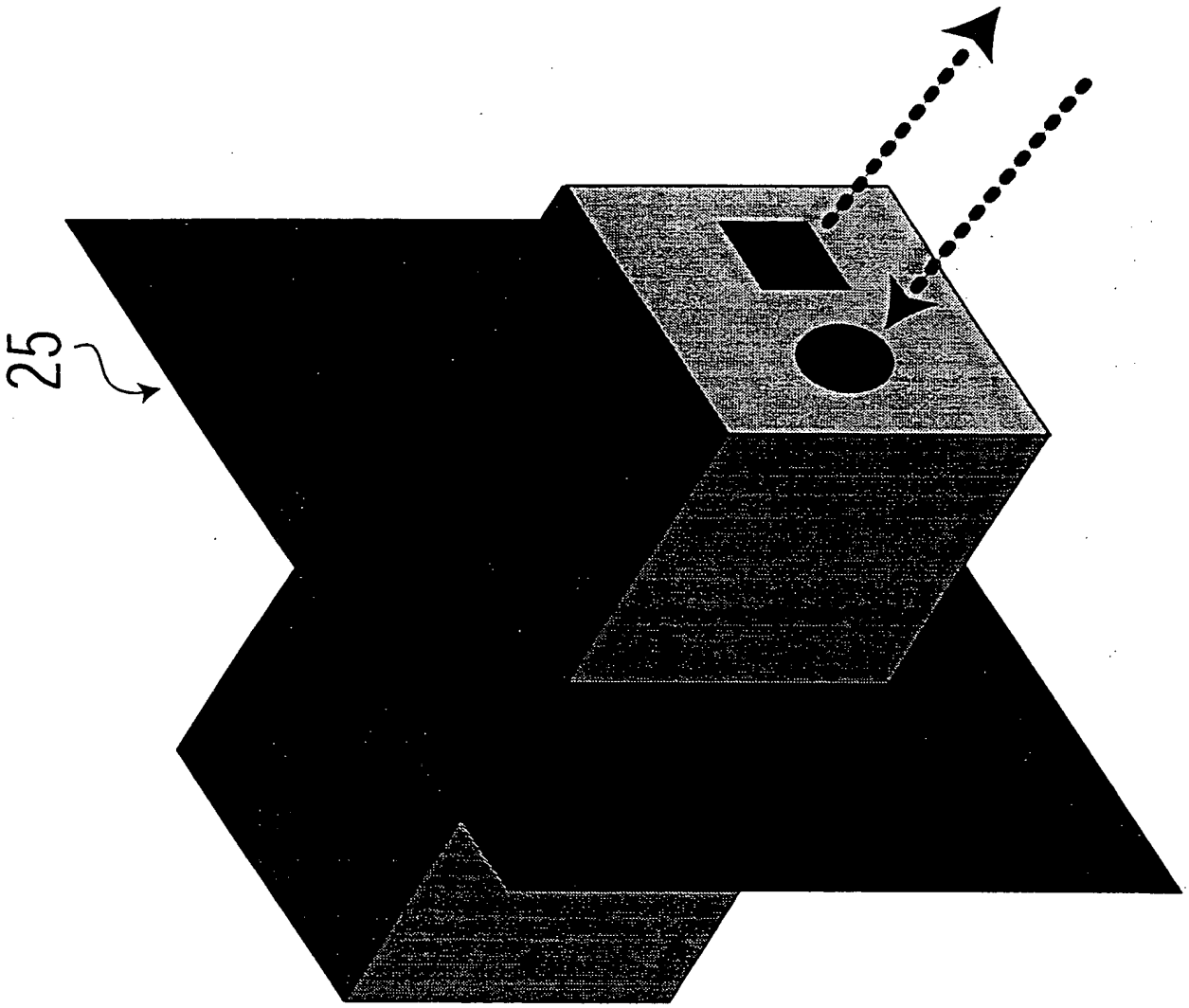


Fig. 3

Fig. 4



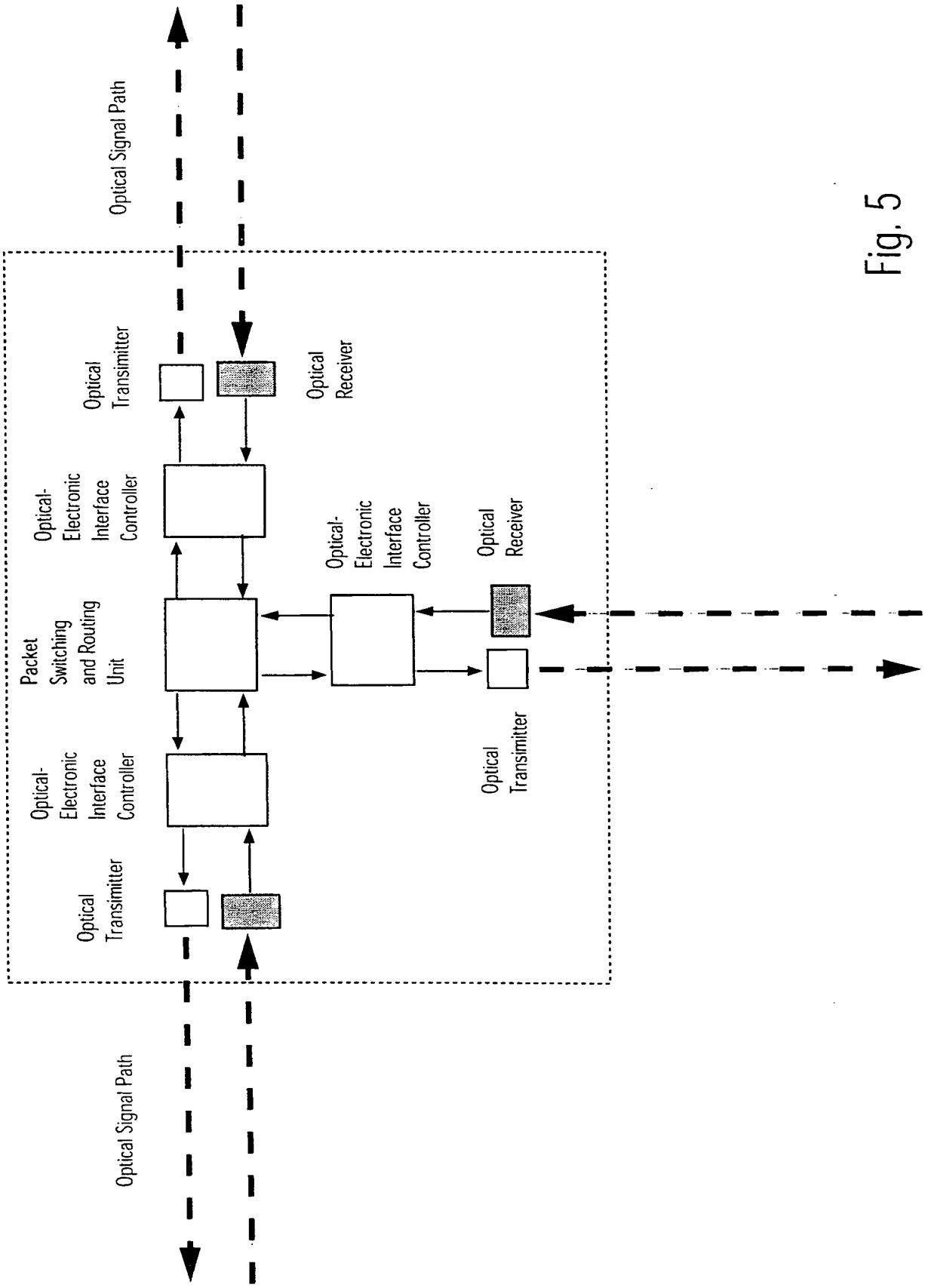


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/01340

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: H04B 10/10, 10/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
WHOLE IPC

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
WHOLE IPC

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: (Network + or interconnect + or Broadband +) and (Laser or optical +) and (repeater? or Transceiver?) and (Pole? or Post? or street light? or Building? or House? or Roof?)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4727600 A (AVAKIAN) 23 February 1988 Whole document	1-13
X	US 4888816 A (SICA, Jr.) 19 December 1989 Whole document	1-13
X	US 5710652 A (BLOOM et al) 20 January 1998 Whole document	13

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
8 December 2000	20 DEC 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer JUZER KHANBHAI Telephone No : (02) 6283 2176

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/01340

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5786923 A (DOUCET et al.) 28 July 1998 Whole document	1-13
X	WO 99/45664 A (AIR FIBER, INC. et al.) 10 September 1999 Whole document	1-13
X	US 5959752 A (OTA) 28 September 1999 Whole document	1-13
P,X	US 5983068 A (TOMICH et al.) 9 November 1999 Whole document	1-13
P,X	US 6049593 A (ACAMPORA) 11 April 2000 Whole document	1-13
P,A	WO 00/33494 A (KHAMSIN TECHNOLOGIES INC. et al.) 8 June 2000 Whole document	1-13
P,A	WO 00/51059 A (KHAMSIN TECHNOLOGIES INC. et al.) 31 August 2000 Whole document	1-13

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 00/01340

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4727600	NONE					
US	4888816	NONE					
US	5710652	US	5731585	US	5754323	US	5801866
		US	5999299	AU	35024/97	BR	9710983
		EP	908028	WO	97/49204		
US	5786923	AU	25490/97	EP	965190	WO	97/37445
WO	99/45664	AU	33108/99	US	6104513		
US	5959752	EP	769858	JP	9172410		
US	5983068	NONE					
US	6049593	NONE					
WO	00/33494	NONE					
WO	00/51059	NONE					

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